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NILOCS-NIMOCC* PROGRAM FINAL REPORT

Report No. 86-309-K

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ABSTRACT

Analysis of the causes of the 1983 pressure tube rupture in Pickering Unit 2 showed that the incorrect location of one of the garter spring spacers was a major contributing factor. The NILOCS-NIMOCC program was established to develop a method of determining the location of these spacers (NILOCS) or to develop a method of determining which channels contained misplaced spacers (NIMOCC) without having to defuel the channels. A number of groups studied a variety of concepts based primarily on vibration phenomena. It has been concluded that none of these concepts is technically feasible. A method that did not require removal of the fuel but involves ingress to the calandria was deemed to be feasible but was not pursued as part of this program.

This report outlines the work done during this program and summarizes the results.

*NILOCS - Non Invasive Location of Channel Spacers
NIMOCC - Non Invasive Monitoring of Channel Condition

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EXECUTIVE SUMMARY

NILOCS-NIMOCC* PROGRAM
FINAL REPORT

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Analysis of the causes of the 1983 pressure tube rupture in Pickering Unit 2 showed that the incorrect location of one of the garter spring spacers was a major contributing factor. Existing spacer location methods require removing the fuel from the channels; a very time consuming and costly process. The NILOCS-NIMOCC program was established to develop a method of locating these spacers (NILOCS) or of determining which channels contained misplaced spacers (NIMOCC) without having to defuel the channels. A number of groups studied a variety of concepts based primarily on vibration phenomena. It has been concluded that none of these concepts is technically feasible. However, a method that did not require removal of the fuel but involves ingress to the calandria was deemed to be feasible but high risk. It was not pursued as part of this program. It is recommended that a more detailed cost-benefit sudy of this method be carried out.

The NILOCS-NIMOCC program was jointly funded by Research Division, Technical and Training Services Division (Central Nuclear Services) and Design and Development Division (Generation). It lasted 25 months and cost $778,000.

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NILOCS-NIMOCC* PROGRAM
FINAL REPORT

1.0 INTRODUCTION

Analysis of the causes of the 1983 pressure tube rupture in Pickering Unit 2 showed that the incorrect location of one of the fuel channel spacers (garter springs) was a major contributing factor. Subsequenty, the Pressure Tube Project, Working Group 4 (Inspection Techniques and Tooling) identified needs for the development of non-invasive methods for accurately locating fuel channel spacers and for improved methods for monitoring fuel channel condition/1.1/. After a number of brain storming sessions and meetings with groups involved in the problem, a Research Division Program was defined to undertake this work/1.2/. The proposed program was established, under the authors' direction, in April 1984. Jointly funded by Research Division, Technical and Training Services Division (CNS) and Design and Development Division, the program co-ordinated the efforts of a number of groups at Research Division in the investigation of a range of possible options. After two years of effort, all currently identified reasonable options have been investigated. Although much has been learned about fuel channel dynamics, it has been concluded that none of the truly non-invasive methods are technically feasible. The preliminary study of a "calandria ingress" method suggests that it is technically feasible but it was decided that further investigation of this option was beyond the scope of the present program.

*NILOCS – Non Invasive Location of Channel Spacers
NIMOCC – Non Invasive Monitoring of Channel Condition

This report reviews the program's organization, the work performed and its total cost. A summary of accomplishments of the program and recommendations for other applications of the developed technology are presented.

2.0 PROGRAM ORGANIZATION

2.1 Personnel

The author was given the responsibility for managing the program under the direction of Mr. J. Cassan, Manager of Divisional Projects.

It was recognized that the wide range of ideas to be explored would require expertise from a number of sections within Research Division. The program manager was required to identify the needed resources and negotiate with the appropriate Section Heads for their use. As much as possible, the work was divided into subprograms that were carried out within the Sections to which they were assigned. Two researchers were hired on contract to provide expertise that was not available within the Division. Table 1 lists the various subprograms undertaken, the personnel involved in each and their affiliation.

2.2 Financing and Cost Accounting Procedures

The NILOCS-NIMOCC Program was jointly funded by Research Division, Technical and Training Services Division (Central Nuclear Services) and Design and Development Division (Generation). During the first year, Research Division paid 20% and each of the others paid 40%. In subsequent years the cost was shared equally among the three.

Because of the diversity of groups participating in the program a special accounting system was established. Only one Project Record Form (PRF) was issued by the program manager to CNS and D&D for the total annual commitment agreed upon. Each Section involved in the program opened two PRF's; a transfer (Class 1) PRF using the clients' end account numbers but signed by the program manager, and a Research (Class 5) PRF. All charges (labour only) were made by workers to the Class 5 PRF's. All material and expense (M&E) charges were made to special PRF's opened by the program manager. At the end of each month the program manager received a cost report from Research Accounting (using a project management number). A spreadsheet computer program was used to determine cost allocation. All M&E costs were divided equally between CNS and D&D because these items were generally of value to all groups working on the program. A Class 5/Class 1 transfer rate was then determined so that each of the three funding groups were charged the agreed upon proportion. The program manager then instructed Research Accounting to transfer the appropriate amount of charges from each Section's Class 5 to their Class 1 PRF. In this way, the project manager had full control of all external charges. An overall monthly cost report was generated as well as individual reports to each Section Head regarding the charges and transfers to their Section's accounts.

2.3 Equipment and Facilities

Most equipment and facilities were provided by Research Division. In particular, two fuel channel mock-ups built to represent, as closely as possible, operational ones were installed in the Nuclear Process Components Test Facility. The mock-ups included real fuel, shield and closure plugs, simulated moderator and cold flow equal to full power flow rates. An instrumentation and clean work area was installed on the plant floor adjacent to the mock-ups.

A number of instruments required for the program but not available at Research were rented and charged to the program.

A Masscomp computer system was needed for data collection and analysis by one of the subprograms. This was jointly purchased by Electrical Research (50%) and CNS/D&D (25% each) with the understanding that, after completion of the NILOCS program the equipment would be retained by Electrical Research. The equipment greatly assisted the generalized cross-correlation and forced modal analysis investigations.

2.4 Reporting and Technical Reviews

Monthly progress reports were issued with brief inputs from each subprogram group and a financial summary/1.10/.

At intervals of approximately 6 months, technical review meetings were held. Research reports documenting the results of each subprogram's work were distributed prior to each meeting and a short summary of each presented at the meeting. Besides representation from CNS and D&D, specialists from AECL/CRNL were invited.

The meetings served a number of useful purposes. They provided a definite time frame for researchers to complete and report segments of work. They provided a regular opportunity for interested parties to review and comment on completed work and provide their views on future direction. Finally they provided the program manager the opportunity to present the proposed program for the next period and to negotiate for continued support as appropriate.

In all, five meetings were held. Table 2 provides the dates and references the reports related to each.

3.0 ACOUSTIC EMISSION (AE) SUBPROGRAM

3.1 Traditional AE Methods

The idea that spacers may rattle or produce transient burst type emissions (stress waves) in the pressure tube during vibration and that acoustic emission source location methods might be used to determine their positions was first proposed by Dr. J.A. Baron/2.1/. Buhay and Green studied this concept/2.2,2.3,2.4,2.5/. Spacer impacts were generated using large amplitude vibration of the endfittings and impacts to the endfittings. However, these techniques were not deemed to be satisfactory for many reasons; there was no assurance that all spacers could be made to

respond equally; the methods were observed to contribute to spacer movement; near simultaneous emissions from multiple sources (up to four spacers as well as spurious emissions from bearings, etc) created difficult analysis; and poor signal to noise ratios in the presence of flow (shutdown as well as full power) compounded the difficulties of reliable detection. It was concluded that the development of a reliable, consistent excitation technique to produce discrete emissions from spacers was not feasible.

3.2 Pattern Recognition and Adaptive Learning Techniques

During the traditional AE work, it was recognized that velocity dispersion and the multiplicity of signals from many sources would create analysis difficulties even if a reliable excitation method could be achieved. Work by Licht at AECL/CRNL suggested that the velocity dispersion and the interference of different wave modes might produce transient characteristics that were uniquely related to the location of the sources in the channel/2.13,2.14/. Methods for analysing and classifying signals are well established in the fields of Pattern Recognition and Adaptive Learning. Sinclair at the University of Toronto/2.15,2.16,2.17/ and Baron and Buhay/2.12/ investigated this concept. The latter study concluded that it was feasible to locate a tap on the pressure tube with one sensor to within 1 metre and using multiple sensors and a combination of techniques improved accuracy might be possible. However, the technique still depended on the development of a reliable, consistent technique for exciting transient emissions. Work in this area was curtailed when it was concluded that such techniques were not feasible.

3.3 Generalized Cross Correlation Techniques

Early in the program information was obtained about American experience with the use of coherence methods for the detection of small leaks in sodium cooled steam generators. Investigations by Green and Leemans/2.6/ showed that this method was a specific case of generalized cross-correlation (GCC) techniques that are used in many applications of vibration analysis. Unlike traditional acoustic emission methods that require the collection of discrete transient waves, GCC techniques analyse continuous signals and have the ability to detect very weak correlated signals that are superimposed on a strong random noise background.

Initial tests on solid bars gave promising results but the complex wave propagation modes in pressure tubes, due to their large diameter and thin wall, limited the useful frequency range which could be used to 200 Hz to 9 KHz/2.7/. Work on a water filled fuel channel showed that, with no flow, taps and individual rattling garter springs could be located on the tube using the GCC methods, but that with flow, the noise was at least 40 dB greater than the observed signals/2.8/. Further work by Buchan and Green/2.9/ showed that multiple spacers acted as wave transmission paths between the calandria tube and pressure tube. Different propagation characteristic of the pressure tube and calandria tube, particularly lower damping of the latter caused a multiplicity of responses at each receiver from each source making interpretation of the resulting correlation impossible. The transmissivity of spacers led to the idea of using them as virtual sources on the pressure tube when controlled moderator side excitation was applied.

3.4 Moderator Side Excitation – Virtual Sources

This method envisaged exciting the calandria tube, either directly or via the moderator, with a controlled signal such as a swept sine wave or chirp. The spacers would transmit the sound to the pressure tube acting as virtual sources. Matched filtering of signals received at the ends of the endfittings could be used to enhance signal to noise and reduce the effects of multiple paths. Buchan and Green found on investigation that the amount of excitation energy arriving at the endfitting via the spacers was very small compared to that transmitted through other structural elements such as end shields and bearings/2.10/. After exploring many possible avenues, it was concluded that this problem could not be overcome and hence this concept was not feasible.

3.5 Modal Analysis

The idea of using controlled excitation from inside the moderator with matched filtering to significantly improve signal to noise ratios led to renewed interest in the modal analysis method explored earlier by the Vibration Monitoring Group (Section 4). This method actually exploits the resonant and dispersive character of fuel channel vibrations to distinguish between channels in different physical states (eg, spacers in the design location or not). Buchan and Green compared theoretical analyses with results of experiments using very slow swept sine excitation to allow high Q resonances to be detected. Excellent correlation between the theoretical and practical work were obtained. However, while fuel channel responses were found to vary significantly with spacer locations they could not be reliably measured due to the dominence of endfitting modes. The method could not be developed into a practical tool/2.11/.

4.0 VIBRATION CONDITION MONITORING SUBPROGRAM

4.1 Vibration Signature Analysis

The concept of using vibration signature analysis to separate fuel channels with spacers in their design location from those with displaced spacers (ie, Go – No Go rather than spacer location) was introduced by Research Division's Plant Equipment Dynamics group shortly after the cause of the Pickering Unit 2 – G16 failure became known. Early results were promising but as a larger sample of channels was tested, it became clear that changes in vibration signature due to factors other than garter spring displacement were dominant/3.1,3.2,3.3/. The above group continued their work as part of the NIMOCC program. Elbestawi, Liska, Lau and Tait/3.4/ developed a computer model of the fuel channel using finite element techniques. Modal analysis testing of the mock-up channel in the Nuclear Process Components Test Facility (NPCT) provided data for validating the computer model. Also, detailed analysis of vibration signatures obtained on Bruce Unit 6 provided results that agreed well with those given by the structural dynamic simulation. Parametric studies were then performed using the finite element model to investigate the sensitivity of vibration modes to garter spring location. This work confirmed that changes in endfitting frequency spectra due to misplaced garter springs were small and too variable to allow a stand alone signature analysis approach to work. However, it suggested the possibility that condition monitoring, ie, com-

parison of spectra with baseline measurements on the same channel might be practical.

4.2 Advanced Signal Processing Methods

Elbestawi and Liska/3.4,3.5/ also investigated the use of advanced signal processing methods such as complex cepstrum and cross correlation techniques. Preliminary complex cepstrum analysis of selected Bruce Unit 6 signatures indicated that this method might be the basis of a Go–No Go classification method but further work did not confirm this. Cross correlation analysis investigations were carried out with and without flow. This work paralleled the work of Green, Leemans and Buchan but took a more empirical approach. A wide variety of tests on the mock–up fuel channel led to the conclusion that, with either full PHT flow or shutdown cooling flow, the signal to noise ratio for rattling spacers was too poor for cross correlation methods to be effective.

4.3 Adaptive Noise Cancellation

An attempt was made by Liska to develop an adaptive noise cancellation (ANC) method to enhance signal to noise ratios (SNR) for vibration signature analysis. This entails collecting or developing a reference signal representative of the noise alone which will be highly correlated with the noise component of the signal to be analysed. By subtracting the reference signal from the collected signal, increases in SNRs can be achieved. Computer simulations using signals recorded on the mock–up suggested improvements of 20 dB might be possible but this could not be achieved during actual mock–up testing/3.7/.

4.4 Vibration Conditioning Monitoring Methods

For the NILOCS/NIMOCC program, vibration condition monitoring methods were defined as those that rely on a comparison of vibration signatures obtained from a given fuel channel at different times. Since the dynamic response of the fuel channel is affected by all of its physical characteristics (not just spacer location), it was proposed that a thorough understanding of its response might allow various aspects of its condition to be monitored. In order for this approach to be viable, stable and repeatable vibration signatures must be obtainable from a given fuel channel. Also, a method of assuring that the same excitation is applied is needed to allow comparison of responses collected at different times. Alternatively, a method of separating the influence on the dynamic response of the driving function (flow noise) from that of the channel's transfer function is required.

Extensive tests were carried out by Liska on Bruce NGS "B" Unit 5 preservice. Signatures were collected on all fuel channels and analysed for stability of frequency content. With the methods employed, a minimum signature record length of 32 seconds was required to obtain reasonably stable spectra. Repeatability of stable responses with constant reactor process conditions was demonstrated by comparing signatures from a group of channels at two times 9 hours apart/3.6/. However, a comparison of vibration signatures on selected Bruce NGS "B" Unit 6 fuel channels collected under nominally the same process conditions but many months apart showed very considerable and inconsistent changes in spectral

content/3.8/. Moveover, it was recognized that significant fuel channel shape changes (primarily sag) take place during the first year of a reactor's life. This probably affects the degree of spacer support and almost certainly will affect the fuel channel's dynamic response. The above, combined with the knowledge that spacer location has an insignificant effect on the channel's endfitting dynamic behaviour (section 4.1), led to the conclusion that vibration monitoring methods are not feasible for determining whether or not a channel's spacers are correctly positioned. A thorough review of the work leading to this conclusion was prepared by Liska/3.8/.

5.0 CALANDRIA INGRESS SUBPROGRAM

NILOCS calandria ingress methods are methods of detecting channel spacers from the outside of the calandria tubes. Although they would require equipment to enter the core of the reactor, they are classified as non-invasive to the extent that they do not require the fuel to be removed from the fuel channels; a very time consuming and costly procedure.

Mader and Woodall investigated calandria ingress methods/4.1/. They concluded that it was feasible to develop a device that enters the calandria via the pressure relief ducts. A tractor device that runs between adjacent calandria tubes could carry eddy current sensors to detect the garter spring spacers. The detection technology already exists. Hence the major task would be designing the delivery system. It would have to withstand a severe radiation environment with high reliability. Because of the inaccessability of the calandria, any failures that could occur would have to be anticipated and recovery methods proven.

It is interesting to note that an earlier study by AECL/4.2/ also suggested that a calandria ingress method was feasible.

The results of both studies were presented early in the NILOCS program. At that time the review panel felt that, although technically feasible, the development of a sufficiently reliable device would be a difficult and very high risk undertaking. It was decided not to proceed with this option as part of the NILOCS program/1.4/. Because no other NILOCS option has proved to be feasible, a more detailed cost benefit study of this option may now be warranted.

6.0 NEW CONCEPTS SUBPROGRAM

This part of the NILOCS program was to identify alternative solutions to the channel spacer location problem. In particular, it was felt important to investigate sources of solutions outside the nuclear community. O'Neill/5.1/ prepared a Request for Proposal (RFP) soliciting ideas from outside organizations. They were distributed to Engineering Departments of Canadian Universities (21), Provincial Research Organizations (8) and Centres of particular expertise in NDE worldwide (9).

Only two responses were received. One from the University of New Brunswick proposed a mechanical vibration scheme requiring defuelling of the channel. Hence it did not meet the "non-invasive" requirement. The second response was from Rockwell International Corporation proposing to build a piece of hardware to

provide very low noise coherence spectra. This proposal was based on the assumption of similarity between the dynamic behaviour of a fuel channel and that of small leaks in liquid sodium steam generators. Since our own studies had shown this not to be the case (section 3.3), the proposal was not accepted.

7.0 PROGRAM DURATION AND COST

The program officially commenced in May 1984. The final review meeting was held on June 19, 1986, 25 months after commencement.

The total cost of the program was $778,000, which was shared as follows:

Research Division	$268,000
Central Nuclear Services	$255,000
Design and Development	$255,000

Cost breakdowns by year and work program are presented in Table 3.

8.0 PROGRAM ACCOMPLISHMENTS AND SPINOFFS

Although the primary objective of developing a non-invasive method to locate channel spacers was not achieved, a much greater understanding of the dynamic behaviour of fuel channels has been gained. The finite element model of a Bruce B fuel channel has already been used to study the effects of a proposed REFAB program for Bruce NGS 'A' Units 1 and 2.

The expertise gained in the area of generalized cross correlation methods may be useful for developing systems for loose parts monitoring in boilers or heat exchangers. Another application of this technology now being investigated is the detection of very low level leaks in pressure tubes such as those that occurred in Bruce Unit 2 in 1982.

Work during this program has furthered our knowledge of frequency and time domain signature analysis techniques which will continue to be used and enhanced to diagnose problems in rotating machinery and other plant equipment.

Adaptive learning and pattern recognition methods are increasingly being used in the area of non-destructive testing and may have application in other fields. Our experience with these techniques during the project has provided an insight to their usefulness.

9.0 SUMMARY AND RECOMMENDATIONS

A Research Division Program was established to develop methods for Non Invasive Location of Fuel Channel Spacers (NILOCS) and for Non Invasive Monitoring of Channel Conditioning (NIMOCC). Jointly funded by Research Division, Technical and Training Services Division and Design and Development Division, the program lasted 25 months and cost a total of $778,000.

Concepts evaluated but found not to be feasible were:

- Traditional Acoustic Emission Source Location;
- Pattern Recognition and Adaptive Learning Techniques;
- Application of Generalized Cross-Correlation Techniques;
- Controlled Moderator Side Excitation – Virtual Sources;
- Vibration Signature Analysis/Modal Analysis;
- Advanced Signal Processing Methods;
- Adaptive Noise Cancellation;
- Vibration Monitoring Methods.

A poll of expertise outside the nuclear community did not lead to any usable new concepts.

The only concept studied that was deemed to be technically feasible was the calandria ingress method. Because it was not truly non-invasive and was high risk (it involves developing a complex remotely controlled vehicle to traverse the labyrinth of calandria tubes, and vertical and horizontal control mechanisms within the high radiation environment of the calandria), the method was not pursued as part of the NILOCS program. However, since no other concept has been found to be feasible, it is recommended that a more detailed cost-benefit study of calandria ingress for spacer location and other possible applications be carried out.

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5. NEW CONCEPTS

5.1 O'Neill, J.A., "NILOCS/NIMOCC Ideas Generation Project: Phase 1 Report", Ontario Hydro Research Division Report No. 84-313-H, 84-09-21.

TABLE 1

NILOCS-NIMOCC Program - Personnel

Subprogram	Principal Personnel	Affiliation
1. Administration	M.P. Dolbey	ND&FE Section
2. Acoustic Emission		
- Conventional	S. Buhay	Contract - Viatech Resource Systems Inc
	M.A. Green	Transmission & Special Projects
	R.S. Algera	ND&FE Section
- Adaptive Learning	J.A. Baron	ND&FE Section
	S. Buhay	Contract - Viatech Resource Systems Inc
- Cross Correlation Techniques	M.A. Green	Transmission & Special Projects
	D.V. Leemans	Contract - Cross Currents Research
	P.G. Buchan	Transmission & Special Projects
3. Vibration Monitoring	M.A. Elbestawi	Plant Equipment Dynamics
	J.J. Liska	Plant Equipment Dynamics
	D. Lau	Plant Equipment Dynamics
	H. Tait	Plant Equipment Dynamics
4. Calandria Ingress Methods	D. Mader	Science Section
	K. Woodall	Science Section
5. New Concepts	J.A. O'Neill	Science Section

TABLE 2

NILOCS/NIMOCC – Technical Review Meetings

Meeting 1. September 26, 1984

References 1.3, 1.4, 1.5, 2.2, 2.3, 2.4, 2.13, 2.14, 3.4, 4.1, 5.1

Meeting 2. December 19, 1984

References 1.6, 1.7, 2.5, 2.6, 3.5

Meeting 3. May 2, 1985

References 2.7, 2.8, 2.12, 3.6

Meeting 4. November 7, 1985

References 1.8, 1.9, 2.9, 3.7

Meeting 5. June 19, 1986

References 2.10, 2.11, 3.8

TABLE 3(a)

NILOCS/NIMOCC Program
Cost Summary 1984

NILOCS /NIMOCC
MONTHLY STATEMENT

Month Ending Dec 31/84

SUBPROGRAM	TOTAL ESTIMATED COST	TOTAL SPENT TO DATE	RESEARCH	CHARGES CNS	D&D
ADMINISTRATION	$43,300.00	$31,014.00	$9,259.23	$10,877.39	$10,877.39
AE SPACER LOCATION	$214,100.00	$167,825.12	$25,181.80	$71,321.66	$71,321.66
VIBRATION MONITORING	$93,000.00	$93,000.00	$27,765.15	$32,617.43	$32,617.43
CALANDRIA INGRESS	$20,000.00	$17,737.00	$5,295.38	$6,220.81	$6,220.81
NEW CONCEPTS	$13,500.00	$11,297.00	$3,372.72	$3,962.14	$3,962.14
SHARED COST-TOTALS	$383,900.00	$320,873.12	$70,874.28	$124,999.42	$124,999.42
PERCENT			22.1%	39.0%	39.0%
RESEACH OVERRUN VIB. MOMITORING		$62,051.00	$62,051.00		
ACTUAL COST-TOTALS	$383,900.00	$382,924.12	$132,925.28	$124,999.42	$124,999.42
PERCENT			34.71%	32.64%	32.64%
SPENT/ESTIMATED %		83.6%			

TABLE 3(b)

NILOCS/NIMOCC Program
Cost Summary 1985

NILOCS /NIMOCC
MONTHLY STATEMENT

Month Ending 19-Dec-85

SUBPROGRAM	TOTAL ESTIMATED COST	TOTAL SPENT TO DATE	RESEARCH	CHARGES CNS	D&D
ADMINISTRATION	$16,000.00	$12,903.00	$6,619.97	$3,141.52	$3,141.52
AE SPACER LOCATION	$154,000.00	$173,767.00	$62,691.34	$55,537.83	$55,537.83
VIBRATION MONITORING	$55,000.00	$65,747.00	$35,778.30	$14,984.35	$14,984.35
NEW CONCEPTS	$0.00	$326.00	$177.40	$74.30	$74.30
SHARED COST-TOTALS	$225,000.00	$252,743.00	$105,267.01	$73,738.00	$73,738.00
PERCENT			41.6%	29.2%	29.2%
SPENT/ESTIMATED %		112.3%			
SPEC DATA ACQ PURCH	$50,000.00			$26,262.00	$26,262.00
COST TOTALS	$275,000.00		$105,267.01	$100,000.00	$100,000.00

TABLE 3(c)

NILOCS/NIMOCC Program
Cost Summary 1986

NILOCS /NIMOCC
MONTHLY STATEMENT

Month Ending 04-Nov-86

SUBPROGRAM	TOTAL ESTIMATED COST	TOTAL SPENT TO DATE	CHARGES RESEARCH	CHARGES CNS	CHARGES D&D
ADMINISTRATION	$28,000.00	$6,064.00	$2,192.44	$1,935.78	$1,935.78
AE SPACER LOCATION	$187,000.00	$73,287.00	$23,982.70	$24,652.15	$24,652.15
VIBRATION MONITORING	$10,000.00	$9,772.00	$3,533.07	$3,119.47	$3,119.47
SHARED COST-TOTALS	$225,000.00	$89,123.00	$29,708.20	$29,707.40	$29,707.40
PERCENT			33.3%	33.3%	33.3%
SPENT/ESTIMATED %		39.6%			

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